REMARKS

Claims 1-6, 29-35, 38-41, 43, and 44 are pending in the application. Claims 1-6, 29-35, 38-41, 43, and 44 stand rejected. Claims 1-6, 29, 33, 41, 43, and 44 are being amended. No new matter is believed to be introduced by way of the amndments .

Rejections Under 35 U.S.C. §112 and Claim Objections

Claims 1-6 and 29-34 were rejected under 35 U.S.C. §112, second paragraph, for being indefinite. Claims 2-6 and 30-34 are also objected to for including informal language. Claims 1, 5, 29, and 33 are being amended to clarify the language of these claims. Accordingly, the objections and rejections of Claims 1-6 and 29-34 under 35 U.S.C. §112, second paragraph, are believed to be overcome.

Rejections Under 35 U.S.C. §101

Claims 41, 43, and 44 were rejected under 35 U.S.C. §101 for being directed to a non-statutory subject matter.

Claims 41, 43, and 44 are being amended to include the term "in a communications system." Accordingly, Applicants respectfully submit that Claims 41, 43, and 44 meet requirements of 35 U.S.C. §101 by being tied to a particular system (*i.e.*, a communications system, which is known in the art to include physical and tangible elements such as transmitters and receivers), and therefore, are statutory subject matter under 35 U.S.C. §101.

Moreover, the U.S. Supreme Court in *Bilski et al. v. Kappos, No. 08-964* opined on June 28, 2010 that the machine-or-transformation test is not the exclusive test for determining patentable subject matter. Accordingly, the excluded categories for patentability are now limited to laws of nature, physical phenomena, and abstract ideas. The subject matter recited in Applicants' Claims 41, 43, and 44 clearly does not fall under these excluded categories.

Accordingly, Applicants respectfully submit that the rejection of Claims 41, 43, and 44 under 35 U.S.C. §101 are overcome. Withdrawal of the rejections is respectfully requested.

Rejections Under 35 U.S.C. §103(a)

- Rejection of Claims 1, 2, 4, 29-30, and 32 in view of Alamouti and Gardner

Claims 1, 2, 4, 29-30, and 32 were rejected under 35 U.S.C. §103(a) as being unpatentable over Alamouti *et al.* (U.S. Patent No. 5,933,421, hereinafter referenced as "Alamouti") in view of Gardner (U.S. Patent No. 5,260,968, hereinafter referred to as "Gardner").

Applicants' Claim 1, as amended, recites (emphasis added):

> An antenna array comprising:
> ***multiple receiving elements*** configured to receive communications signals over a carrier frequency from the plurality of remote units, at least two receiving elements configured to receive the communication signals on a same frequency band during any period of time, the receiving elements ***being partitioned into a plurality of groups disposed remotely from one another by at least a predetermined minimum group spacing sufficient to obtain spatial diversity***, each group containing at least one receiving element, ***at least one group including multiple receiving elements located proximal to one another and no farther apart than a predetermined maximum receiving element spacing to facilitate spatial filtering***.

Alamouti employs a system in which a base station receives a first incoming signal, including a plurality of first Orthogonal Frequency Division Multiplexed (OFDM) frequency tones F2, in a first frequency band, from a first remote station U, during a first Time Division Multiple Access (TDMA) interval. The base station also receives a second incoming signal, including a plurality of second OFDM frequency tones F4, in the first frequency band, from a second remote station W, during a second TDMA interval. The first and second remote stations, U and W, receive the first and second sets of discrete frequency tones F2 and F4 during different periods of time (see Fig. 1 and Column 9, line 19-65 of Alamouti).

The present Office Action acknowledges that Alamouti fails to teach having receiving elements "being partitioned into a plurality of groups disposed remotely from one another by at least a predetermined minimum group spacing sufficient to obtain spatial diversity, …., at least one group including multiple receiving elements located proximal to one another and no farther apart than a predetermined maximum receiving element spacing to facilitate spatial filtering," and combines Gardner with Alamouti to remedy these deficiencies of Alamouti.

Gardner performs spatial filtering by using a multi-element antenna array with a large number of elements. In order to adapt the antenna array, Gardner uses a spectral coherence restoral (SCORE) method that employs the spectral redundancy of the received signals. In order to maximize spatial resolution while preventing ambiguities (grating lobes), the antennas in the antenna array are typically separated by approximately one half of the wavelength of the highest frequency in the reception band (see lines column 6, 4-8 of Gardner).

Therefore, Gardner merely arranges the elements in a single antenna array by a predetermined spacing. Gardner offers no suggestion of partitioning the receiving elements "into a plurality of groups disposed remotely from one another," such that "each group contain[s] at least one receiving element."

A hypothetical system combining the teachings of Alamouti and Gardner may include antenna elements positioned at preset or appropriate distances from one another, but would not include partitioning receiving elements "into a plurality of groups." Given that the hypothetical system would have no notion of elements partitioned into groups, the hypothetical system cannot include "plurality of groups disposed remotely from one another by at least a predetermined minimum group spacing sufficient to obtain spatial diversity," as recited in Applicants' Claim 1.

One of ordinary skill in the art would not be motivated to modify the hypothetical system to behave as recited in Applicants' Claim 1 because the cited references are not designed to operate within partitioned groups. Rather, in contrast to Applicants' Claim 1, these references are designed to operate without partitioning the receiving elements into groups. Therefore, a modification that would enable the hypothetical system to operate within the partitioned group would require substantial modification, effectively changing its principles of design, and only be done in hindsight of Applicants' teachings.

Therefore, it is Applicants' position that Claim 1 is allowable over Alamouti in view of Gardner. Accordingly, Applicants respectfully request that the rejection of this claim under 35 U.S.C. § 103(a) be withdrawn.

Claim 29 includes similar elements as Claim 1. Accordingly, Applicants respectfully request that the rejection of this claim under 35 U.S.C. § 103(a) be withdrawn.

Because Claims 4, 30, and 32 depend from Claims 1 and 29, Applicants respectfully submit that these claims should be allowed for at least the same reasons as the base claims from which they depend.

- Rejection of Claims 3, 5-6, 31, and 33-34 in view of Alamouti, Gardner, Chang, and Paulraj

Claims 3 and 31 were rejected under 35 U.S.C. §103(a) as being unpatentable over Alamouti in view of Gardner and further in view of Chang *et al.* (U.S. Patent No. 5,414,433, hereinafter referred to as "Chang").

Claims 5-6 and 33-34 were rejected under 35 U.S.C. §103(a) as being unpatentable over Alamouti in view of Gardner and further in view of Paulraj *et al.* (U.S. Patent No. 5,345,599, hereinafter referenced as "Paulraj").

Chang is being combined with Alamouti and Gardner because these references do not teach a "predetermined minimum spacing no more than five times a wavelength." However, Chang does not teach or suggest having "the receiving elements being partitioned into a plurality of groups disposed remotely from one another by at least a predetermined minimum group spacing sufficient to obtain spatial diversity," as required by Applicants' Claims 1 and 29.

Paulraj employs a spatial filter that separates *m* received input signals into the *d* distinct transmitted *signal components*. Subsequently, corresponding *d* spatial filter channels are used to accept *m* inputs and operate on these with *d* single or multi-tap tapped delay line filters to yield *d* desired outputs. Paulraj offers no suggestion of dividing receiving elements (physical beings and not signals) into groups.

Rejected Claims 3, 5-6, 31, and 33-34 depend from base Claims 1 and 29. As explained above, Alamouti and Gardner do not teach all of the elements recited in base Claims 1 and 29. These limitations of Alamouti and Gardner are not cured by Chang and Paulraj. Therefore, without discussing or acquiescing to the merits of the reasons for rejecting these claims, it is Applicants' position that these claims are allowable over Alamouti and Gardner alone or in view of Chang and Paulraj. Accordingly, Applicants respectfully request that the rejection of Claims 3, 5-6, 31, and 33-34 under 35 U.S.C. § 103(a) be withdrawn.

- Rejection of Claim 35 in view of Alamouti , Gardner, and Reece

Claim 35 was rejected under 35 U.S.C. §103(a) as being unpatentable over Alamouti in view of Gardener and further in view of Reece *et al.* (U.S. Patent No. 5,771,024, hereinafter referred to as "Reece").

Claim 35 recites (emphasis added):

> An adaptive antenna array architecture for communication, the architecture comprising:
>
> a plurality of adaptive antenna arrays for signal reception, **the plurality of adaptive antenna arrays including a plurality of sub-arrays, each sub-array including at least two receiving elements, the receiving elements in the sub-arrays being located no farther apart than a predetermined maximum receiving element spacing to facilitate spatial filtering, wherein the sub-arrays being spaced to obtain spatial diversity;**
>
> an array fixation structure configured to position the plurality of adaptive antenna arrays;
>
> an array support structure for positioning the array fixation structure at a desired elevation; and
>
> a base station configured to control the adaptive antenna array architecture.

As explained above, a hypothetical system combining teachings of Alamouti and Gardner can only include *single* antenna elements that are positioned at preset or appropriate distances from one another. The combination of these references offers no suggestion of partitioning adaptive antenna arrays into "a plurality of sub-arrays" such that each sub-array includes "at least two receiving elements ... wherein the sub-arrays being spaced to obtain spatial diversity," as suggested by Applicants' amended Claim 35.

Reece is being combined with Alamouti and Gardner because these references do not teach "an array fixation structure configured to mount the plurality of adaptive antenna arrays thereon." Reece merely relates to an antenna mount and does not teach or suggest partitioning adaptive antenna arrays into "a plurality of sub-arrays" such that each sub-array includes "at least two receiving elements ... wherein the sub-arrays being spaced to obtain spatial diversity," as suggested by Applicants' amended Claim 35.

- Rejection of Claim 38 in view of Paulraj and Shattil

Claims 38 was rejected under 35 U.S.C. §103(a) as being anticipated by Paulraj in view of Shattil *et al.* (U.S. Patent No. 6,008,760, hereinafter referred to as "Shattil").

Claim 38 recites (emphasis added):

> A signal receiver for receiving communications signals, the receiver comprising:
> an adaptive array configured to receive signals from remote units;
> a plurality of demodulator units configured to process the signals;
> ***a plurality of beamformers configured to construct a desired signal response pattern as a function of direction of arrival data of the signals, the desired signal response pattern providing a higher relative gain in one or more angular directions and minimizing co-channel interference in other angular directions***; and
> a spatial diversity combiner configured to remove interference from the signals.

Paulraj relates to a receiving station that includes *m* receiver front-end outputs that are input to a spatial filter. The spatial filter employs the *m* signals to estimate *d* separate impinging signals. The *d* spatial filter outputs signals that are processed by a *d*-channel demodulator and decoder that demodulates the signals to obtain digital data streams and decodes the data streams to generate the *d* sub-streams. The demodulator outputs are then combined. The combiner is "simply a d-way multiplexer" (see column 8, lines 11-49 and shown in Figs. 5 and 6 of Paulraj) that receives the demodulator/decoder signals, aligns the signals to compensate for differential delays experienced by the signals, and combines the time aligned signals to obtain an estimated source stream.

Paulraj may employ the direction of arrival information to separate co-channel signals into individual signals prior to feeding them into the demodulators. However, in contrast to Applicants' Claim 38, Paulraj neither employs the direction of arrival information to "construct a desired signal response pattern" nor requires the combined signal to include a pattern that has "a higher relative gain in one or more angular directions and minimizing co-channel interference in other angular directions."

The present Office Action acknowledges that Paulraj fails to teach having receiving elements "construct a desired signal response pattern as a function of direction of arrival data of the signals, the desired signal response pattern providing a higher relative gain in one or

more angular directions and minimizing co-channel interference in other angular directions," and combines Shattil with Paulraj to remedy these deficiencies of Paulraj.

Shattil describes an antenna array 100 that is coupled to an interferometric beam-narrowing processor 303. The antenna array 100 may have a plurality M of reception patterns corresponding to a plurality of signal frequencies. Control of the radiation pattern is achieved by relative positioning of the elements n and the relative electrical excitations of the individual array elements n (column 6, lines 57-60).

Therefore, in contrast to Applicants' Claim 38, Shattil merely controls the radiation pattern based on relative positioning of the elements. Shattil Paulraj neither employs the direction of arrival information to "construct a desired signal response pattern" nor requires the combined signal to include a pattern that has "a higher relative gain in one or more angular directions and minimizing co-channel interference in other angular directions."

A hypothetical system combining the teachings of Paulraj and Shattil may have a direction of arrival processor, but it will not have a combiner that constructs "a desired signal response pattern" that satisfies the requirements of Applicants' Claim 38.

One of ordinary skill in the art would not be motivated to modify the hypothetical system to include a combiner that constructs "a desired signal response pattern" because such modification requires significant modification of the hypothetical system (e.g., calibration, careful determination and implementation of gain and phase weightings) and would only be done in hindsight of Applicants' teachings. Specifically, since Shattil merely controls the radiation pattern based on relative positioning of the elements, one would need to modify the hypothetical system to instead construct the desired signal pattern and satisfy the requirements of Applicants' amended Claim 38. Such modification clearly would require substantial alteration of the hypothetical system, effectively altering its fundamental principles of operation (controlling a signal vs. constructing a desired signal having certain requirements), and would only be done in hindsight of Applicants' teachings.

- Rejection of Claim 39 in view of Paulraj, Shattil, and Forssen

Claims 39 was rejected under 35 U.S.C. §103(a) as being anticipated by Paulraj in view of Shattil and further in view of Forssen *et al.* (U.S. Patent No. 5,566,209, hereinafter referred to as "Forssen").

Forssen merely employs direction of arrival data in combination with factors, such as weighting and minimization of an error signals, to enhance a training sequence used as a desired signal. Foressen's combiner neither constructs "a desired signal response as a function of direction of arrival data of the signals" nor requires the combined signal to include a pattern that has "a higher relative gain in one or more angular directions and minimizing co-channel interference in other angular directions," as required by Applicants' amended Claim 38.

Rejected Claim 39 depends from base Claim 38. As explained above, Paulraj and Shattil do not teach all of the elements recited in base Claim 38. These limitations of Paulraj and Shattil are not cured by Forssen. Therefore, without discussing or acquiescing to the merits of the reasons for rejecting this claim, it is Applicants' position that this claim is allowable over Paulraj and Shattil alone or in view of Forssen. Accordingly, Applicants respectfully request that the rejection of Claim 39 under 35 U.S.C. § 103(a) be withdrawn.

- Rejection of Claim 40 in view of Paulraj, Forssen, and Alamouti

Claims 40 was rejected under 35 U.S.C. §103(a) as being anticipated by Paulraj in view of Forssen and further in view of Alamouti.

Alamouti is being combined with Paulraj and Foressen because these references do not teach employing OFDM. However, as described above, these references do not teach requisite elements of Applicants' Claim 38, from which Claim 40 depends.

These limitations of Paulraj and Foressen are not cured by Alamouti. Therefore, without discussing or acquiescing to the merits of the reasons for rejecting this claim, it is Applicants' position that this claim is allowable over Paulraj and Foressen alone or in view of Alamouti. Accordingly, Applicants respectfully request that the rejection of Claim 40 under 35 U.S.C. § 103(a) be withdrawn.

- Rejection of Claim 41 and 44 in view of Ward, Langlais, and Frodigh

Claims 41 and 44 were rejected under 35 U.S.C. §103(a) as being anticipated by Ward *et al.* (U.S. Patent No. 6,104,930, hereinafter referenced as "Ward") in view of Langlais (U.S. Patent No. 6,091,932, hereinafter referenced as "Langlais") and further in view of Frodigh (U.S. Patent No. 5,726,978, hereinafter referenced as "Frodigh").

Claim 41, as amended, recites (emphasis added):

> A method for reducing signal interference in a communications system, the method comprising:
> assigning at least one widely spaced frequency bin to a user, each bin being in a neighborhood of bins belonging to other users;
> spacing the at least one frequency bin belonging to the user to at least one sufficiently different frequency in a ***dominant direction of arrival of signals in each bin as a function of minimizing signal strength of active bins to reduce inter-bin interference***; and
> locating the at least one frequency bin with at least one frequency bin of other users such that directions of arrival for the users are distinctly separable.

Ward employs a system in which each beam is substantially spatially fixed. Ward's beams operate at carrier frequencies that are "sufficiently separated from each other so as not to cause interference with each other or with other beams radiating in adjacent cells." As such, if a mobile station operating at a carrier frequency falling within a first radiation beam moves out of an area covered by that radiation beam and into an area covered by an adjacent second radiation beam, communication with the base station via the first beam is lost, and the base transceiver station must communicate with the mobile station through the second radiation beam (see column 8, lines 6-10 and Fig.7 of Ward).

Therefore, Ward merely separates beams based on their carrier frequencies to ensure that they do not interfere with each other. Ward offers no suggestion of spacing the frequency bins "in a dominant direction of arrival of signals in each bin" and based on "minimizing signal strength of active bins," as required by Applicants' Claim 41.

Langlais explains that since OFDM employs a large number of narrow band sub-carriers, a symbol period in an OFDM system may be hundreds to thousands of times greater than other systems. In order to prevent intersymbol interference, Langlais merely increases a

sample period such that the symbol times are much longer than significant echo paths (see column 4, lines 52-55).

Therefore, Langlais merely suggests increasing a symbol period to prevent inter-symbol interference. Langlais does not teach or suggest spacing the frequency bins "in a dominant direction of arrival of signals in each bin" and based on "minimizing signal strength of active bins," as required by Applicants' Claim 41.

Frodigh relates to a frequency division multiplexed cellular telecommunications system that divides an arbitrary geographic area into a plurality of contiguous radio coverage cells. Each of the cells is associated with a base station and includes a transmitter, a receiver, and a base station controller. Similar to other traditional OFDM systems, Frodigh describes selecting a time period T such that it is relatively large as compared with symbol delay time on the transmission channel to reduce intersymbol interference caused by receiving portions of different symbols at the same time.

Therefore, Frodigh merely suggests increasing a time period to prevent inter-symbol interference. Frodigh does not teach or suggest spacing the frequency bins "in a dominant direction of arrival of signals in each bin" and based on "minimizing signal strength of active bins," as required by Applicants' Claim 41.

A hypothetical system combining the teachings of Ward, Langlais, and Frodigh may prevent inter-symbol interference, but it would not space the frequency bins "in a dominant direction of arrival of signals in each bin" and based on "minimizing signal strength of active bins."

One of ordinary skill in the art would not be motivated to modify the hypothetical system to includes elements recited in Applicants' Claim 41 because such modification requires significant alteration of the hypothetical system and would only be done in hindsight of Applicants' teachings. For example, the hypothetical system would need to be modified to determine and operate based on dominant direction of arrival of signals instead of operating based on an increased symbol period. Such modification requires significant alteration and would only be done in hindsight of Applicants' teachings.

Accordingly, Applicants respectfully request that the rejection of Claim 41 under 35 U.S.C. § 103(a) be withdrawn.

In addition to what was described above, Ward maintains a pool of unassigned and allowable individual carrier frequencies. Depending on the number of incoming calls, these individual carrier frequencies are allocated based on traffic activity. Ward monitors underutilized carrier frequencies (i.e., carrier frequencies having a number of vacant communication channels) and reallocates these time slots to other carrier frequencies on the beam (see column 10, line 37 to column 11, line 42 of Ward).

Therefore, Ward merely assigns unassigned carrier frequencies based on traffic activity. Ward does not teach or suggest "distributing the bins within the frequency blocks as a function of power of the bins," as recited in Applicants' Claim 44.

As noted above, Ward merely assigns unassigned carrier frequencies based on traffic activity and Langlais and Frodigh only suggest increasing a symbol period to prevent inter-symbol interference. These references, independently or combined, do not teach or suggest "distributing the bins within the frequency blocks as a function of power of the bins," as recited in Applicants' Claim 44.

A hypothetical system combining the teachings of Ward, Langlais, and Frodigh may prevent inter-symbol interference, but it would not distribute "the bins within the frequency blocks as a function of power of the bins."

One of ordinary skill in the art would not be motivated to modify the hypothetical system to include elements recited in Applicants' Claim 44, because such modification requires substantial modification of the hypothetical system and would only be done in hindsight of Applicants' teachings. For example, the hypothetical system would need to determine power of the bins and distribute the bins based on the power of the bins.

Accordingly, Applicants respectfully request that the rejection of Applicants' Claim 44 under 35 U.S.C. § 103(a) be withdrawn.

- Rejection of Claim 43 in view of Ward and Frodigh

Claims 43 was rejected under 35 U.S.C. §103(a) as being anticipated by Ward in view of Frodigh.

As explained above, Ward maintains a pool of unassigned and allowable individual carrier frequencies. Depending on the number of incoming calls, these individual carrier frequencies are allocated based on traffic activity.

Therefore, Ward merely assigns unassigned carrier frequencies based on traffic activity and Frodigh merely suggests increasing a time period to prevent inter-symbol interference. Ward and Frodigh do not teach or suggest "assigning the second remote user to a second frequency bin based at least in part on the directions of signal arrival such that directions of signal arrival for adjacent frequency bins differ," as recited in Applicants' Claim 43.

One of ordinary skill in the art would not be motivated to modify Ward and Frodigh to include elements recited in Claim 43, because such modification requires substantial modification of the hypothetical system and would only be done in hindsight of Applicants' teachings. For example, the modification requires that Ward's system be altered to assign the bins based on direction of arrival as opposed to traffic activity.

Accordingly, Applicants respectfully request that the rejection of Claim 43 under 35 U.S.C. § 103(a) be withdrawn.

CONCLUSION

In view of the above amendments and remarks, it is believed that all now pending claims, Claims 1-6, 29-35, 38-41, and 43-44, are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

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